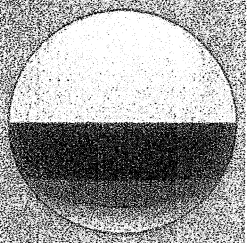
UH60L Upgrade

for

DAAVA, Colombia



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May 2019 | 19PRP0-03

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ROM
Price Proposal

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May 19th, 2019

To: DAAVA, Colombia

Subject: **ROM Price for UH60 upgrade to Colombian Air Forces**
Ref. no: 19PRP0-03

Dear Sir,

Elbit Systems LTD (ESL), a leading global company in the defense industry specializing in helicopter upgrade solutions, is honored to submit this commercial price proposal.

We strongly believe that this proposed solution is ideally designed to address the Colombian DAAVA requirements and provides a solution that meets current and future challenges.

The proposed tactical upgrade suite for the Colombian Army provides functions to enhance Mission Success and Survivability. The proposed solution will unify all helicopters different configurations to a standard one, improve maintainability and solve obsolescence problems of the H/C.

The proposal, detailed in the following chapters, includes one Universal FMS and Four (4) MFD, which control and display **Primary Flight Display** and **Digital Map** application, thus enhancing Mission Management through improved *Situational Awareness*. The System will enable real time tactical pictures and FMS flight plan and data display.

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Proposal Ground Rules and Assumptions

Price

1. The price for the helicopters upgrade suite (2 Options)

   Option 1 125'5

   A. One (1) Prototype UH60L: $28M.
      Note: Prototype installation by Elbit Systems.
   B. Each additional UH60L: $2M.
      Fleet modification and installation by DAAVA.

   Option 2 80'

   A. Forty (40) serial UH60L: $2.5M per 1 UH60L.
      Note: Prototype installation by Elbit Systems and Fleet modification and installation by DAAVA..

2. This Price Proposal is stated in USD and presented in FY 2019 economics conditions.

3. Purchase Orders entering into force after 31 December 2019 will be subject to a 3% yearly escalation.

4. The pricing in this proposal may change due to different requirements. Any changes or adjustments in the requirements may be priced accordingly.

5. The Price does not include any allowance for purchase tax, goods and services tax, duties, levies, income tax, withholding tax, customs fee; value added tax (VAT), stamp duty taxes, offset obligations or similar charges that may be imposed outside the state of Israel.

Payments

6. We assume the following payments schedule:

   - 40% of the contract price - Advance Payment.
   - Residual payment – upon agreed milestones table and deliveries – will be defined in the contract.

   Payments shall be made within twenty (20) days after submission of the invoice in USD through irrevocable, revolving LC issued by a first rated international bank acceptable to ESL.

Deliveries

7. Delivery point: Deliveries will be according to INCOTERMS 2010 – DAT (Delivery At Terminal) Colombia Entrance Port. The Customer will be responsible for releasing the goods, delivered by ESL and/or its sub-contractors, from customs and deliver it to the installation location in a timely manner.

   Partial Shipments will be allowed. ESL will notify the Customer two weeks in

advance about readiness of the deliveries.

GFE/GFI/GFS

8. The Customer will provide all necessary Government Furnished Equipment (GFE), Government Furnished Information (GFI), and Government Furnished Services (GFS) as detailed in the proposal. Any delay in receipt of the customer's GFE/GFI/GFS will entitle the Seller to adjust the program schedule accordingly.

Export Control

9. The proposed program is pending export licenses approval. ESL will be responsible to manage the export license process needed for the program from any governmental authorities subject to any required End User Certification and other pertinent customer documentation.

   End Use/ End User Certificate and other pertinent customer documentation will be required in the format provided by ESL.

Warranty

10. The Warranty will be for a period of One (1) year starting from delivery. The repair will be done at ESL or its subcontractor's premises.

Specific Terms

11.
- This price proposal assumes that all the aircraft are in the same configuration.
- The prices indicated above don't include any financing elements. Elbit is able to support the Customer with allocating competitive suitable financing solution that will be customized to customer needs.

Terms & Conditions

12. All other Terms and Conditions not detailed in this proposal will be mutually agreed on a later stage.

Validity

13. This proposal will remain valid until 31 December 2019.

Confidentiality

14. The customer is requested not to disclose any portion of this Proposal, its Annexes, or any other supplement or any information submitted in connection herewith to any third party without ESL's written consent.

Elbit Systems LTD. Proprietary Data

15. This price proposal includes data that shall not be disclosed to any other party other than the Purchaser without the prior written approval of ESL, and in addition may be disclosed on a need to know basis only to Purchaser's employees who are directly concerned with this proposal ("Authorized Recipients"), and shall not be duplicated, transferred, used or disclosed, in whole or in part, for any purpose other than to evaluate this proposal. Buyer shall remain liable for Authorized Recipients use of the disclosed data. If, however, a contract is awarded to ESL as a result of, or in connection with, the submission of this proposal, the Purchaser will have the right to use the information contained in this proposal to the extent provided by a resulting contract. This restriction does not limit The Purchaser's right, to use information contained in this proposal if it is legally obtained from another source without restriction or if it is in the public domain. The data subject to this restriction may appear anywhere in the attached

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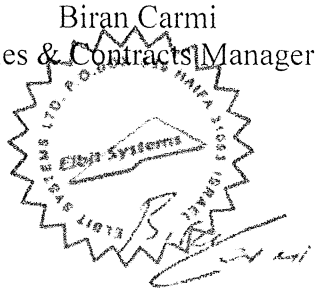
proposal.

All the data provided by ESL relating to this proposal is for the purposes of this Program and is the sole proprietary of ESL, and the Purchaser acknowledges ESL proprietary rights to the data and items to be provided by ESL. Technical data subject to this program will be provided with Limited Data Rights.

ESL thanks you for the opportunity to submit its proposal. We are confident that you will find it responsive to your needs and we look forward to working with you on this important program. Our technical and commercial teams as well as our management are fully committed to cooperate with the customer providing the technical expertise and the best value proposal with cost-effective prices. For any further information regarding this proposal, please contact the undersigned at telephone no. +972-77-2947448 or via email biran.carmi@elbitsystems.com.

Respectfully,
Biran Carmi
Sales & Contracts Manager



DRAFT

Technical Proposal
&
Operational Concept

Elbit Systems™
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Technical Proposal

For

Colombian DAAVA UH-60L Helicopters Upgrade

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1.1 PROPOSED SOLUTION

The proposed tactical upgrade suit for the Colombian Army provides functions to enhance Mission Success and Survivability. The proposed solution will unify all helicopters different configurations to a standard one, improve maintainability and solve obsolescence problems of the H/C.

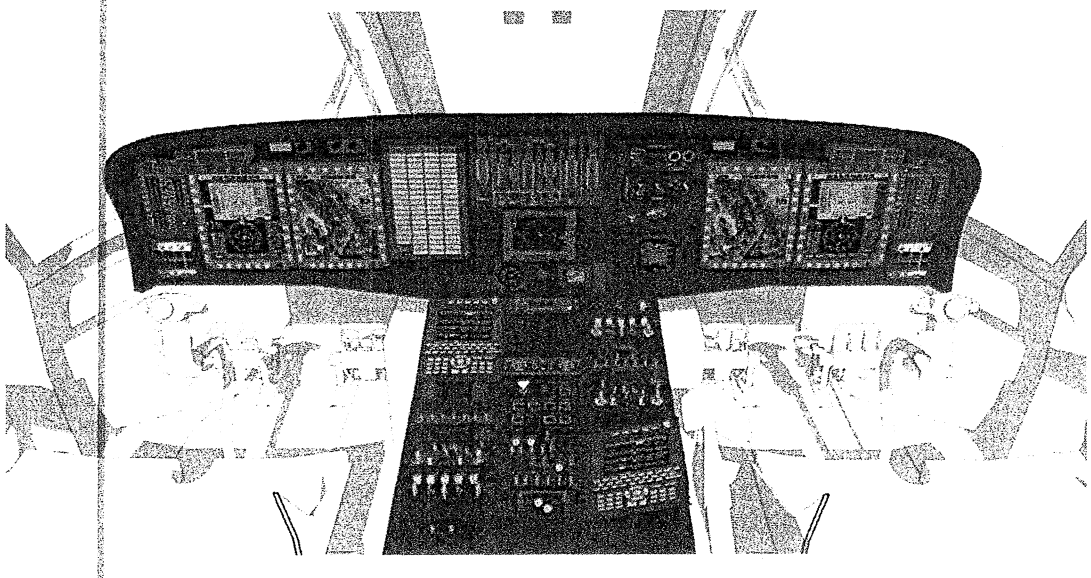


Figure 1: Proposed Modified Cockpit layout

The proposal, detailed in the following chapters, includes Universal FMS/GPS and four Multi-Functional Displays (MFD), which control and display Primary Flight Display (PFD) and Digital map (DMAP) application. The DMAP displays relevant information and cueing to enhanced Mission Management through situational awareness. The System will enable real time tactical situation and FMS flight plan and data display. The DMAP was designed and built in order to answer the modern battlefield requirements and to supply the crew with the ability to execute its mission using advanced interface.

The upgrade suite will enhance the capabilities of the UH60 helicopters by providing better survivability characteristics, a better situational awareness, and the capability to operate in both day and night.

The solution minimises both programme and technical risks by maximising the use of state-of-the-art yet off-the-shelf products. All system components are operational and in use in other helicopter upgrade programmes.

2. PROPOSED OPERATIONAL CONCEPT

2.1 GENERAL

The cockpit controls and displays have a critical role as the Human Machine Interface (HMI) between the avionics system and the flying crew. Effective design & specification of the cockpit avionics will significantly increase the flight safety, reduce crew workload, improve situational awareness, improve the CRM (Crew Resource Management) and will eventually maximize the missions' performance.

The proposed system shall include two new AHRS, replacing the existing gyros providing better reliability and more accurate attitude information that will be displayed on the digital PFD. four (4) portrait oriented MFDs (two in front of each pilot) will allow each pilot to display the PFD and the Digital Moving Map (DMAP) simultaneously.

A single FMS/GPS and two MCDUs will be installed allowing the crew to control all commercial navigational aid and radio communication from one place as well as inserting\editing flight plan (FLP), landing and take-off procedures and managing mission data like bearing and distance to the navigation point, time calculations and fuel consumption.

The DMAP will display the helicopter present position in real time and all FMS mission related data along with different layers of data, allowing the pilots to visually capture the scenery resulting improved crew situational awareness and enhance the CRM additionally, Helicopter Terrain Avoidance Warning System (HTAWS) application will be integrated in the system, alerting the crew visually and audibly for terrain proximity

.

2.2 MAIN APPLICATIONS

The proposed solution enables both pilots to manage all components, functions and applications from a single place in the helicopter. The tactical and avionic data is available for both pilots.

The following components and applications shall be added:

1. One Universal FMS+GPS + SSDTU loader
2. Two MCDU
3. Two U/VHF radio
4. Two VOR/ILS devices
5. One ADF device
6. One DME device
7. One VHF encrypted radio (Tadiran)

8. One IFF (include ADS B out)
9. Four SMFDs for control and display of:
    a. PFD
    b. Digital navigation display (NAVD)
    c. Digital moving map (DMAP)
    d. HTAWS

2.3 OPERATIONAL BENEFITS

- Unified helicopter configuration
    - Reduce maintenance costs
    - Reduce human error
- FMS
    - Improve mission efficiency
    - Enhance safety in civilian airspace
- PFD
    - Each Display can provide a PFD display independently
    - Data sharing and comparison between Displays' calculations and information
- DMAP
    - Improved navigation capabilities
    - Improved situational awareness

2.4 OPERATIONAL SCENARIO

The relative scenario is a common operational scenario of carrying ground troops, in formation, into the threatened areas at night. This section will demonstrate the impact of the proposed solution on the operation.

Flight to the operational area:

A high altitude route may be chosen, to avoid the mountains. The flight plan planned in the FMS is displayed over the DMAP on the desired scale. The pilot will display the HAT function, enabling to detect any risks at a short glance. A final check for the main and alternate Landing Zones will be performed over the DMAP.

Wounded troop's evacuation:

The helicopter receives communication via the encrypted VHF radio that some troops are wounded and need to be evacuated immediately. The crew enters the wounded position coordinates in the FMS and get a direct flight plan is displayed over the DMPA, allowing the crew to understand the terrain and tactical picture on his way to the extraction point. The crew can synchronize ETA with the force on ground advising the accurate landing time.

Flying back to base:

On the way back to the base the skies are starting to overcast. The crew can plan the relevant STAR procedure to the base, to be displayed on the DMAP. Via the FMS the crew will set the frequency for the VOR/ILS device to get the glide slope and localizer indication for safely descending along the procedure

Take off from the LZ:

Displaying the alternate flight plan will help the crew to avoid the threat. The rest of the formation and escorting helicopters will have the alternate route as well, limiting verbal un-necessary communication between the helicopters. The helicopters will clear the area in a short time, minimizing the chance of being detected. On the way home, if bad weather is resulting IFR flight and landing, the selected chart will guide the crew with the correct data.

3. SUB -SYSTEMS OPERATIONAL CONCEPT

3.1 FLIGHT MANAGEMENT SYSTEM (FMS)

3.1.1 FMS GENERAL DESCRIPTION

The "heart" of the navigation system is the Flight Management System (FMS), which centralizes all navigation sources and provides the data required by the pilots and the autopilot in order to maintain correct lateral and vertical path.

Universal Avionics UNS-1Fw FMS will provide all of the required navigational capabilities, from calculating the basic navigational data, such as bearing and distance to waypoints and performing real-time fuel calculations.

A single FMS will be installed, embedded with a commercial GPS/SBAS receiver that internally provides position data to the FMS, in order to allow civil area navigation and published standard instrument departure/approach procedures according to the Required Navigation Performance (RNP or RNAV).

3.1.2 FMS FUNCTIONAL DESCRIPTION

The UNS-1Fw FMS integrates a wide variety of functionalities, including but not limited to the following:

3.1.2.1 Navigation data calculations

The FMS automatically performs basic navigation calculations, such as: desired track, bearing to waypoint, distance to waypoint, cross-track, ground speed and track, lateral and vertical deviations, wind data (which can be pre-set by the crew), Estimated Time of Arrival (ETA) to destination and to waypoints along the flight plan route. It is also possible to perform course offset flight at a distance defined by the crew.

3.1.2.2 Flight planning

Flight plan can be keyed-in on the MCDUs, or uploaded from a memory device (such as USB flash or SD card) through the Solid State Data Transfer Unit (SSDTU). The flight plan can be prepared on a PC Mission Planning software, such as Falcon View, Jeppesen Jet Planner, etc., then converted to Universal format and copied to a memory device:

- Up to 200 Flight Plans can be stored in the FMS, each up to 98 waypoints long.
- Up to 200 user-defined waypoints can be created and stored in the FMS.
- Two flight plans are available: active and alternate. Each can be defined, modified and activated on demand. A pre-loaded flight plan will remain active if the crew decides to land during a planned route. The Active flight plan will be displayed over the DMAP

3.1.2.3 Navigation database

The FMS accepts and stores a loadable Jeppesen ARINC-424 worldwide aeronautical navigation database with a 28-day cycle. This database preparation process is compliant with DO-200 requirements. The FMS uses the navigation database to load and present relevant aeronautical information and perform calculations for ground, take-off, climb (including SID – Standard Instrument Departure), cruise, approach (including STAR – Standard Terminal Arrival Route) and landing operations.

3.1.2.4 Real-time Fuel Management

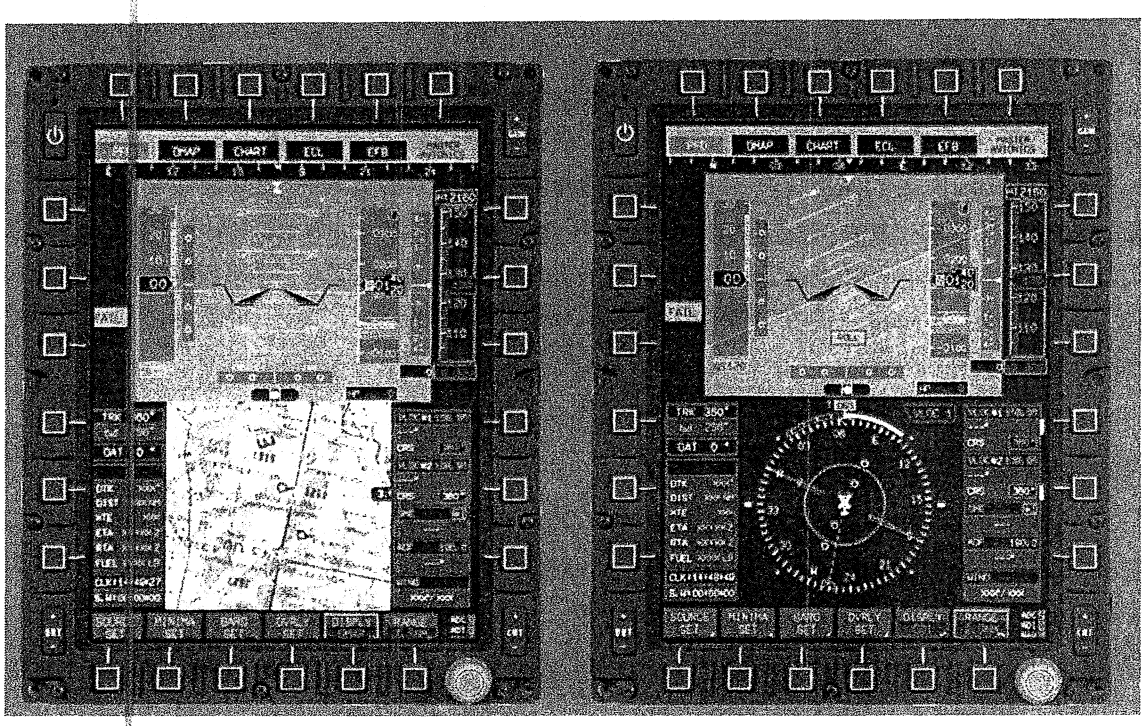
Using inputs from Fuel Flow sensors and the crew, the FMS performs real-time fuel calculations at all waypoints ahead and at destination, as well as specific range and endurance. The fuel data can be entered and displayed in either pounds (lbs) or kilograms (kg).

3.2 SMART MULTI FUNCTIONAL DISPLAY (SMFD)

Four touch-operated SMFD will be installed in the front panel, two in front of each pilot. The SMFDs will allow the pilot to operate and digitally display the helicopter instruments and navigational data, DMAP application and set helicopter parameters and alerts

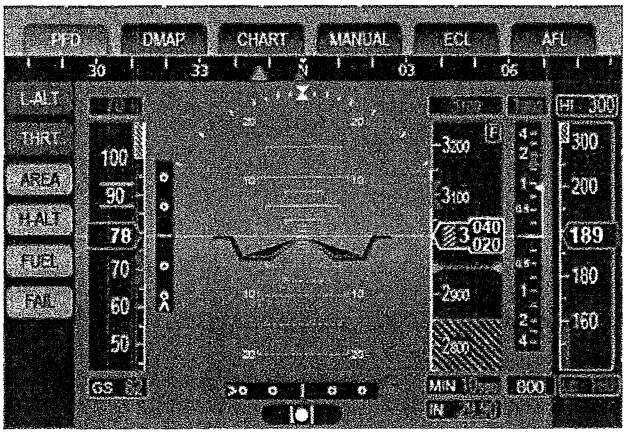
3.2.1 PFD, NAVD

Each crew member can set the display according to his needs, at any given time, in the air.



PFD

The Primary Flight Display (PFD) consists of the basic flight instruments and additional aircraft and navigation data. Specially designed by our pilots to meet helicopter flight characteristics in order to provide the pilot with the ability to quickly locate and understand the desired data.



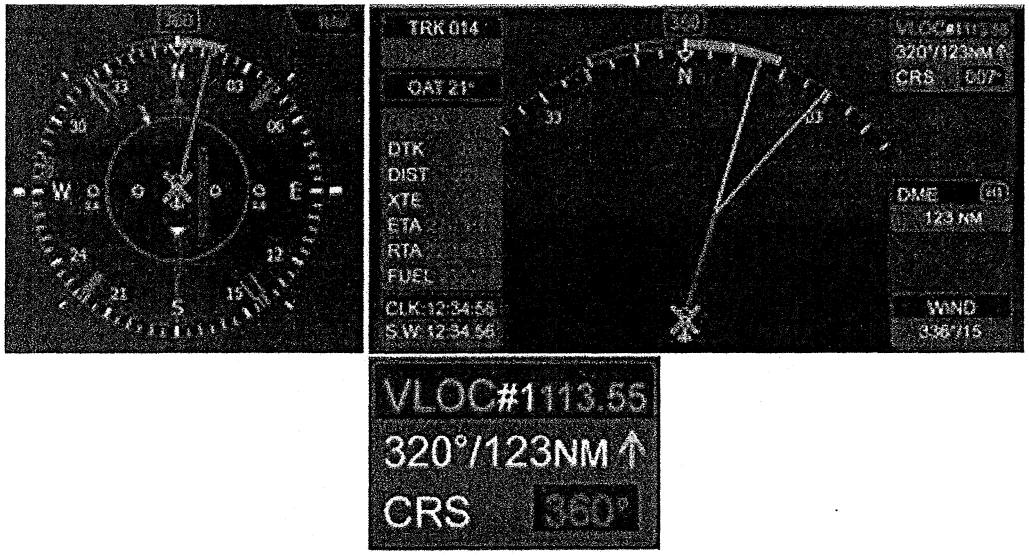
The PFD includes the following modules:

- Upper compass area: displays the magnetic / true heading and the NAV aid direction markers (needles) as set in the NAVD
- Centred Horizon area includes Aircraft Reference symbol, Horizon line and Pitch scale
- Speed area includes Air, Ground speed scale and digital value, Required speed bug (when RTA is available), Maximum speed (Dynamic VNE), Yellow zones (to alert from VNE or low speed) and Red zone (above VNE)

- Altitudes and vertical speed area includes :
  - Altitude scale, value, Selected Altitude (bug and digital value readout), BARO altitude units indication
  - Ground altitude indication
  - Vertical speed scale, pointer, value, speed bug (symbol)
- Lower information area includes Marker beacon indication, Slip/Skid indicator, Minima box and Barometric pressure box
- Deviation scales area includes Approach lateral deviation scale, Approach lateral deviation pointer, Approach vertical deviation scale and Approach vertical deviation pointer
- Alert area: display of selected alerts.

NAVD

The Navigation Display (NAVD) is a horizontal navigational display used to provide air awareness for the flight crew at all times. It includes a display of a directional rose and navigation data. The module includes a display of navigation aids (DME, VOR, ILS).



3.3 DIGITAL MAP (DMAP)

The goal of the DMAP function is to improve aircrew situational awareness by presenting a real time image of the helicopter's current location on top of a moving map, supplemented with detailed navigational and mission information. In addition to the map imagery the DMAP supplied geo-referenced and terrain reference calculations such as: Line of sight, single point elevation, geo-coordinate at a specific screen coordinate and threatened areas. The DMAP provides an interface for controlling different aspects of the displayed map image such as zoom, scale, map background, displayed layer control orientation and more. The DMAP function communicates with the Flight Management System (FMS) and continuously updates its navigational and tactical information according to it.

Figure 2: Digital Map

3.3.1 MAP DISPLAY MODES

The DMAP provides different types of map image backgrounds. Each type is generated in real-time from a different type of database files that are read, processed and rendered for display in a seamless manner. The following are the Map display modes:

- Raster scanned map mode
- Aeronautical maps mode
- Topographical maps mode
- Satellite maps mode
- None – No backgrounds mode, only layers are displayed.

3.3.1.1 Aeronautical Maps Display Mode

The Elbit Systems map supports reading and displaying of standard US National Geospatial Intelligence Agency (NGA) CADRG (MIL-PRF-89038) database files. CADRG files of the following scales are supported:

- 1:50,000 Topographic Line Maps (TLM)
- 1:100,000 Topographic Line Maps (TLM)
- 1:250,000 Joint Operations Graphics (JOG)
- 1:500,000 Tactical Pilotage Charts (TPC)
- 1:1,000,000 Operational Navigation Charts (ONC)
- 1:2,000,000 Jet Navigation Charts (JNC)

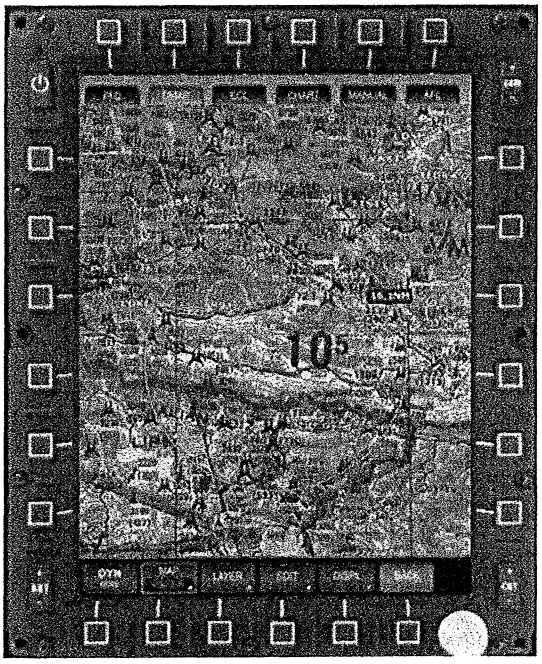


Figure 3: Aeronautical Map

3.3.1.2 Topographic Display Mode

The map supports reading and displaying of topographic maps, generated on ground station originated from Digital Terrain Elevation Data (DTED) levels 1 & 2 (MIL-PRF-89020B) database files and cultural vector database VMAP 0 and VMAP 1.

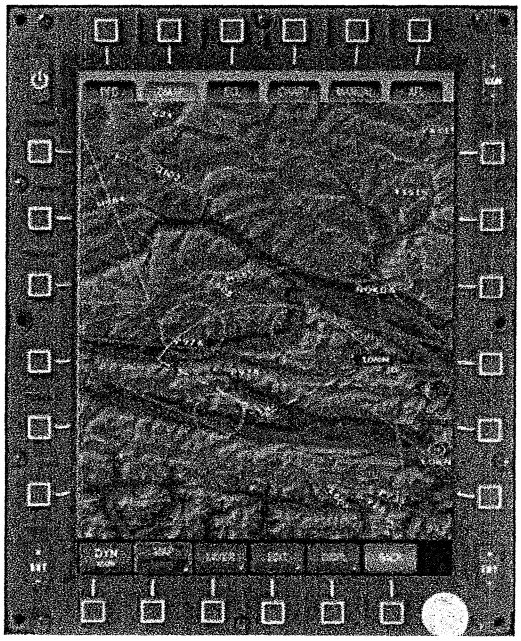


Figure 4: Topographic Map

3.3.1.3 Satellite Map Display Mode

Satellite image display mode is based on Controlled Image Base (CIB) (MIL-PRF-89041) or CADRG (MIL-PRF-89038) format and provides high resolution imagery display.

The satellite image display mode supports the following scales

- 5m per pixel resolution – 1:33K scale
- 10m per pixel resolution – 1:66K scale

Figure 5: Satellite Map

3.3.1.4 None Display Mode

None display mode presents all the mission data over a black background. This mode allows the pilot to focus on the tactical data without the interference of the background colors.

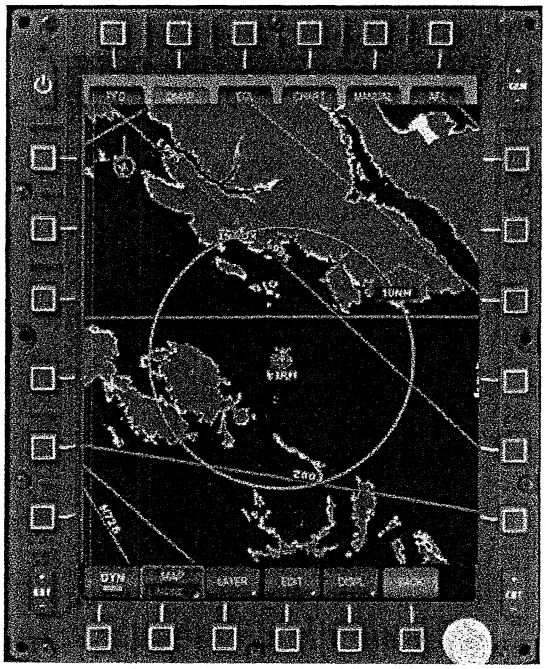


Figure 6: None Display Mode

3.3.2 MAP CAPABILITIES

The DMAP provides the following capabilities:

- Real-time presentation of the Helicopter position on top of a moving map
- Image scrolling according to cursor position
- Zoom
  The Map provides the capability to expand the display around the display Center Of Rotation (COR). At a specific zoom in/out level (ratio of 1:1 to 2:1). The digital map response immediately to zoom change. Once the operator chooses a different zoom the digital map software stretches the map image accordingly using the graphics accelerator capability
- Scale
  The map can change the current scale to lower/higher scale (respectively) in order to give the pilot the best image available in the database
- Layers de-clutter
  The Map provides the capability to remove or to display the different tactical and navigational layers
- Center of rotation
  The Map provides the capability to display the Helicopter symbol at the center of the display or at the lower 25% from the bottom of the display
- North Up/Heading up/Track Up
  The Map provides the following capabilities of map image alignment:
  North Up: The map is orientated to the North
  Heading Up: The map image is oriented according to the aircraft heading
  Track Up: The map image is oriented according to the track direction
- On position/On Helicopter
  The Map provides the capability to display an image centered around the Helicopter present position or on a different position.

3.3.3 MAP LAYERS

3.3.3.1 Flight Plans

The DMAP displays the active flight plan from the FMS.

Figure 7: Flight Plans and Waypoints

3.3.3.2 Tactical Information

The DMAP display the following type of tactical information:

- Threats symbols:
  The DMAP threats symbols are displayed as overlaid symbols over the base map, and are geo-positioned according to the threat parameters.
- Threats indivisibility:
  The DMAP displays the threatened area within the threat detection radius (threat Indivisibility) as translucent coloured overlay. It is a real-time indication of the threatened area within the detection radius of a threat, based on the helicopter's current altitude and terrain elevation data. The translucent display enables the crew to see the underlying map layers, thus providing visibility of the entire map information.

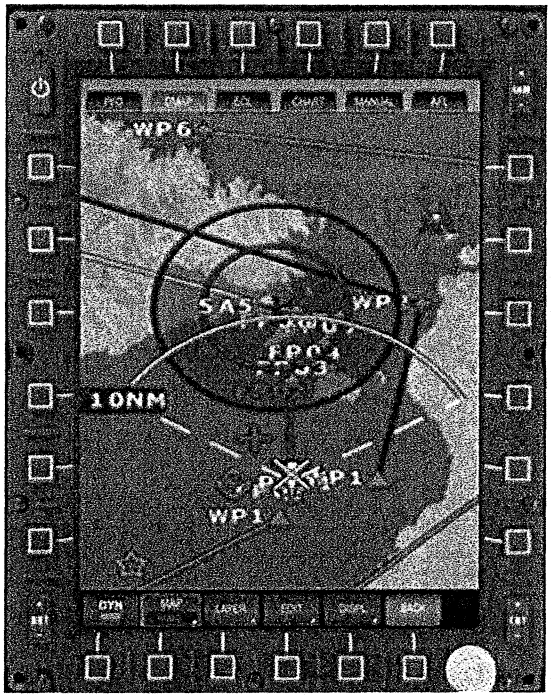


Figure 8: Threat Intervisibility

- User Waypoints – The DMAP displays user waypoints that represent ground forces, barracks, hospitals or a general entity.

3.3.4 DMAP MOVEMENT

The digital map software draws all the displayed symbols (Helicopter symbol, flight plan, waypoints, threats, aeronautical data etc.) each cycle. Each cycle the screen position of all the items and map background is updated according to the Helicopter's movement and attitude and that allows the map information to move smoothly with the aircraft.

3.3.5 HEIGHT ABOVE THRESHOLD (HAT)

The Height Above Threshold (HAT) overlay highlights regions on the display where terrain is higher than a specified elevation. This elevation could be the current Helicopter altitude, or planned mission altitude. Regions above this altitude are shaded translucent red, and regions at this altitude are shaded translucent yellow. This provides critical terrain awareness information, integrated with a translucent overlay on the rest of the map display. This overlay is dynamically updated in real time.

The DMAP displays the HAT as a translucent overlay superimposed on either a topographic map display, aeronautical chart display or a satellite display.

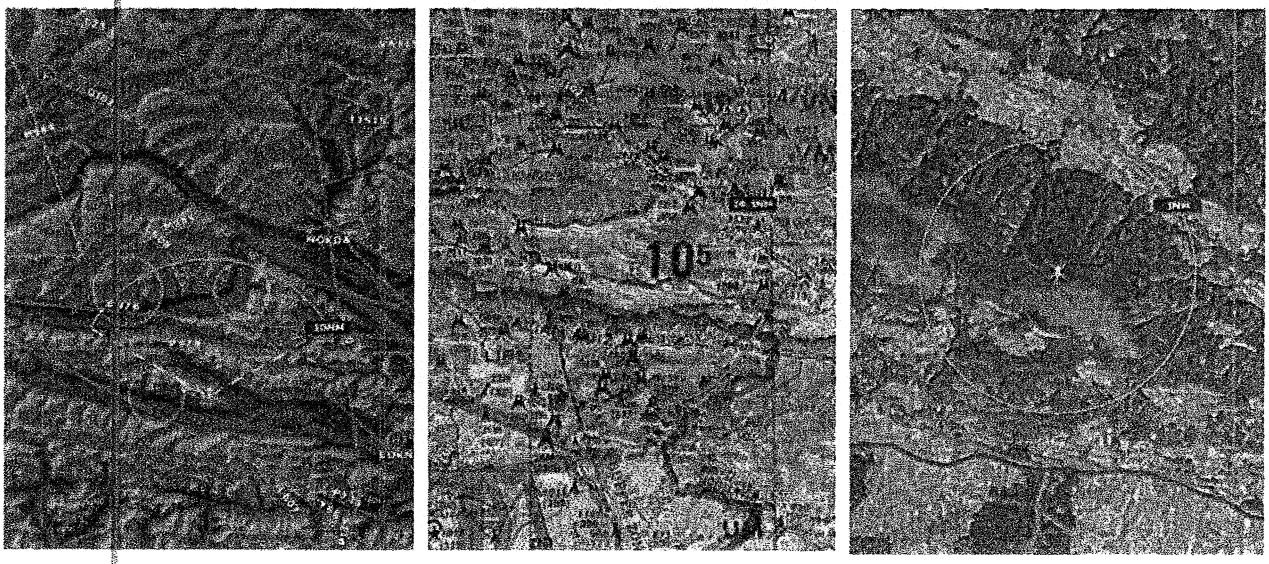


Figure 9: Different Maps With HAT Overlay

4. SYSTEM ARCHITECTURE

The proposed upgrade is based on the following core avionics components:

- 4 x Smart Multi-Functional Display (SMFD)
- 2 x Multi-Function Control Display Unit (MCDU)
- 1x Flight Management System (FMS) which include GPS sensor
- 1x Backup Flight Instrument (BFI)

Two of the displays will be configured and function as Primary Flight Displays. The remaining two displays will present MFD display formats. The inboard MFD displays will support reversion to PFD formats in the event of a PFD failure.

In case of total SMFDs failure the independent BFI will supply attitude/altitude/velocity and heading display.

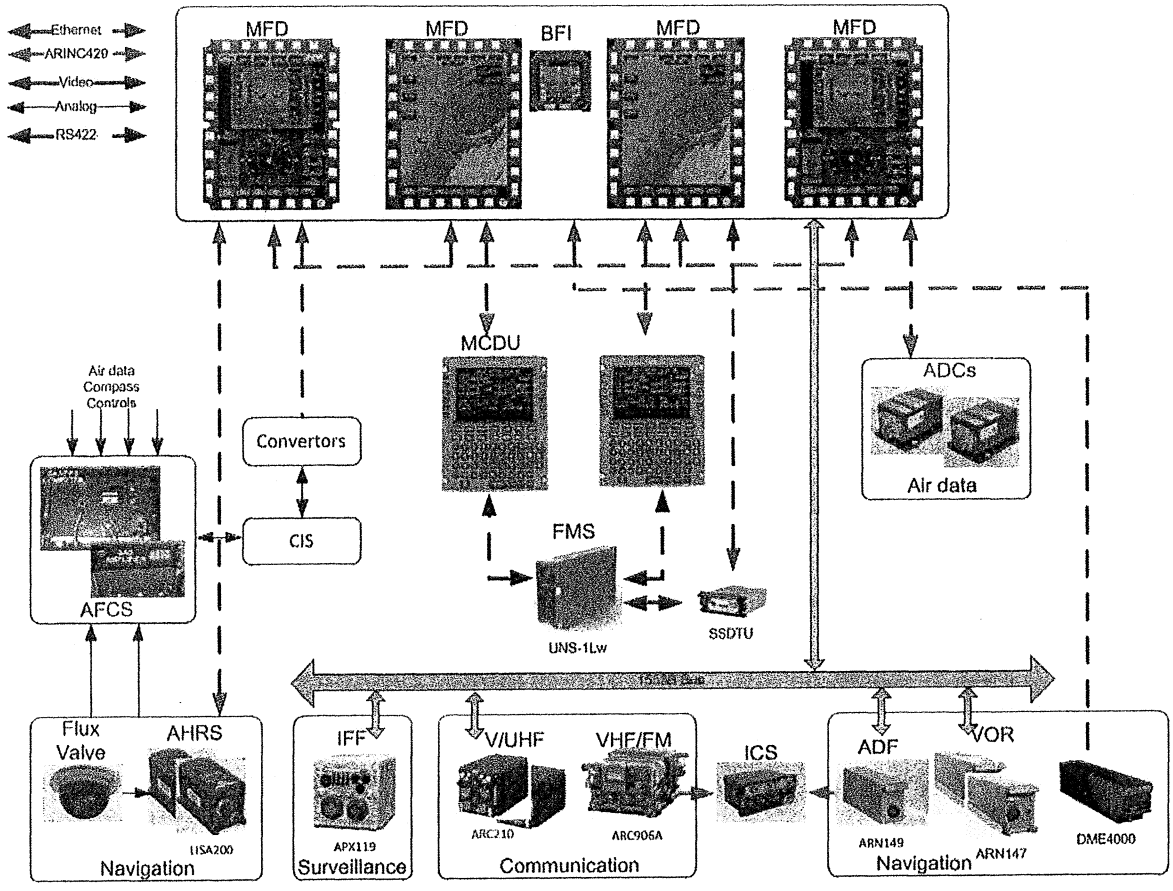


Figure 10: Proposed COLAR UH-60 Architecture

4.1.1 GENERAL

The architecture discussed here is represented in Figure 10: Proposed COLAR UH-60 Architecture. The display system utilizes numerous digital buses as well as some analog and discrete data for interface and control.

4.1.2 ATTITUDE & HEADING SYSTEMS

Dual LISA-100 Attitude and Heading Reference System (AHRS) sensors supplied by Northrop Grumman are proposed. These sensors will provide the primary attitude and heading references for all systems that require this data with the exception of the required dissimilar standby instrument display. The primary interface format for data from the AHRS will be via ARINC 429 High Speed buses. The #1 AHRS will directly interface to the Left PFD and Left MFD. The #2 AHRS will directly interface to the Right PFD and Right MFD displays. All displays can access data from any AHRS unit via the Network buses.

The AHRS will be integrated with the existing AFCS.

4.1.3 AIR DATA SYSTEMS

The exiting ADCs will be kept and its data will be integrated into the new avionics.

4.1.4 SHORT RANGE NAVIGATION

Dual Collins ARN-147 VOR/LOC/GS/MB units and one Collins AN/ARN-149(V) ADF unit will provide short range navigation information to the Displays. This allows approval to landing approach with appropriate monitoring. The can be digitally controlled by the core avionics System without any further development and will reduce weight and power consumption in the installation.

Collins DME-4000 Distance Measuring Equipment interrogator will be installed. This unit is also controlled and tuned by the display system.

4.1.5 LONG RANGE NAVIGATION / RNAV

Single UNS-1Fw Navigation Computer Unit will be installed to provide navigation. This TSO C-146 / 115b approved system provide full regime navigation from take-off to touchdown. Each Flight Management Computer incorporates an embedded SBAS GNSS sensor. this sensor also provide the required position data to the transponders for ADS-B Out approvals. All flight phases including non-precision approaches are supported. Extensive navigation database information is available world-wide for the FMS allowing navigation in all ICAO regions including Departure (SIDS), Terminal, Enroute, Arrival (STAR), Approach Transition and Approach Segments. Where authorities allow it, the FMS can execute NDB approaches without relying on the NDB signals. The FMS supports arc segments including RF

legs, AF legs, Procedure Turns, DME Arcs and Holding Patterns all flown automatically.

4.1.6 RADIO TUNING

The display system provides radio control and tuning via MCDU and pages tailored for each radio being controlled or tuned. This control and tuning function provides tuning and control of the following radios:

- Dual V/UHF Radios
- Dual Nav Radios including functions
- Single DME Radio
- Single ADF Radio
- Single IFF Transponder

4.1.7 TRANSPONDERS

Single Raytheon APX-119 transponder is proposed to provide required Modes 1, 3/A, C, and expanded squitter to support ADS-B Out.

4.1.8 FLIGHT DIRECTOR / AUTOPILOT

The exiting AFCS will be kept and its data will be integrated into the new avionics.

4.1.9 ENGINE AND SYSTEMS DATA DISPLAYS

The exiting engine, Caution / Warning lights will be .

5. MAIN UNITS TECHNICAL DESCRIPTION

5.1 SMFD

The smart display presenting high performance, mission displays in size 10.4" diagonal, slim, lightweight and low power consumption.

SMFD can display its own video generation or external video sources, highly sophisticated smart models featuring extensive processing and interface capabilities.

Figure 11: SMFD

5.1.1 MAIN FEATURES

- High brightness and contrast for direct sunlight visibility
- Full NVG compatibility

- Saturated colors in both day and NVG modes for vibrant reds and yellows
- Extra wide viewing angles with uniform brightness and colors
- Advanced LED backlight - no power consuming lamp heaters
- Instant turn-on to maximum brightness at any ambient temperature
- High resolution
- Optimized electronics for enhanced image quality for both digital graphics and sensor imagery
- Passive cooling - no forced air required, no fans

5.1.2 TECHNICAL INFORMATION

The SMFDs are Touch controlled. The SMFDs Touch operation is mainly for the Digital Map graphic operation and Alpha-Numeric Keyboard.

The SMFD Bezel includes the following:

- 24 keys
- 1 OFF/ON key
- Rotary Knob
- +/- Rocker for brightness intensity of the display.
- +/- Rocker the video gain adjustment.
- +/- Rocker for contrast control of the superimposed symbology.

Dimensions	263mm (H) x 212mm (W) x 200mm (D) Including connectors
Display area	127.8 mm x 170.4 mm, in portrait orientation
Resolution	XGA (1024 x 768 pixels)
MFD Power	145W power consumption including heaters
Luminance	720cd/m2
Viewing angle	±60° horizontal, ±60° vertical, no inversions (Maximum performance are achieved at ±30° horizontally and +40°/0° vertically from display normal).

5.2 BACKUP FLIGHT INSTRUMENT - BFI

The GH-3900 Electronic Standby Instrument System (BFI) represents the next-generation of standby instrument technologies and capabilities for mid- to large cabin business turboprops and jets and helicopters, as well as air transport category aircraft. Along with being a full-function standby ADI, the GH-3900 offers pilots an unmatched array of configuration options, including customizable colors and visual flight cues, as well as displayed information tailored to Part 23 (Class III & IV), 25, 27 and 29 aircraft and helicopters.

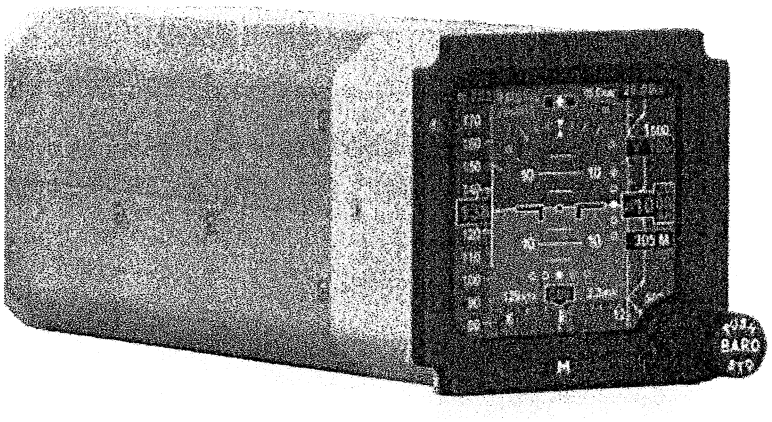


Figure 12: BFI

5.2.1 MAIN FEATURES

The BFI will display the following parameters:

- Attitude
- Barometric corrected altitude
- Airspeed
- Vertical speed
- Slip indication
- Heading

5.2.2 TECHNICAL INFORMATION

Dimensions	250 (D) mm x 83(W) mm x 83(H) mm	
Attitude and heading performance	Attitude	Accuracy: error less than or equal to 2.5 degrees in pitch and roll with valid air data
	Heading	2 degrees static on ground with magnetometer. Latitude: +/- 70 degrees. Dip angle exclusions for northern Canada and South of Australia

5.3 MULTI-FUNCTION CONTROL DISPLAY UNIT (MCDU)

Developed for airline or special mission operations, the MCDU features additional ARINC 429 I/O ports which can support up to six ARINC 739 interfaces for Satcom and future NextGen CNS/ATM systems.

The MCDU interfaces with the UNS-1Fw computer.

Figure 13: MCDU

5.3.1 MAIN FEATURES

The MCDU is used for:

FMS control

U/VHF control

IFF control

VOR/ILS control

ADF control

5.3.2 TECHNICAL INFORMATION

Dimensions	181mm (H) x 146mm (W) x 200mm (D)
Display area	5-inch color Flat Panel Display, in portrait orientation
Power	75W power consumption (max)

5.4 UNS-1FW FLIGHT MANAGEMENT SYSTEM

The UNS-1Fw FMS contains a Wide Area Augmentation System (WAAS) subsystem. The WAAS subsystem provides a navigation solution using GPS augmented by WAAS.
The FMS may contain up to six databases: navigation, company route, checklists, performance, pilot-defined, and FMS flight plan. All databases can be updated via a Data Transfer Unit (DTU). This DTU is housed within a protective case that may be panel mounted in the cockpit for convenient access. The FMS will have the ability to store two cycles of the Navigation and Company Routes databases.
A self-contained worldwide NAV database stored in non-volatile memory provides the FMS with information on over 100,000 waypoints, navaids, airports, and over 12,000 SIDs, STARs and approaches. The operator may choose from a worldwide database with airport runways of >2000 feet or >4000 feet.The pilot-defined database is stored in nonvolatile memory. It has the capacity to store up to 200 pilot-defined enroute waypoints, 200 pilot-defined routes and 100 each pilot-defined enroute alignment points, airport reference points, runways, and approaches.
The FMS computer is configured to a specific aircraft installation through a configuration module which is part of each aircraft installation.

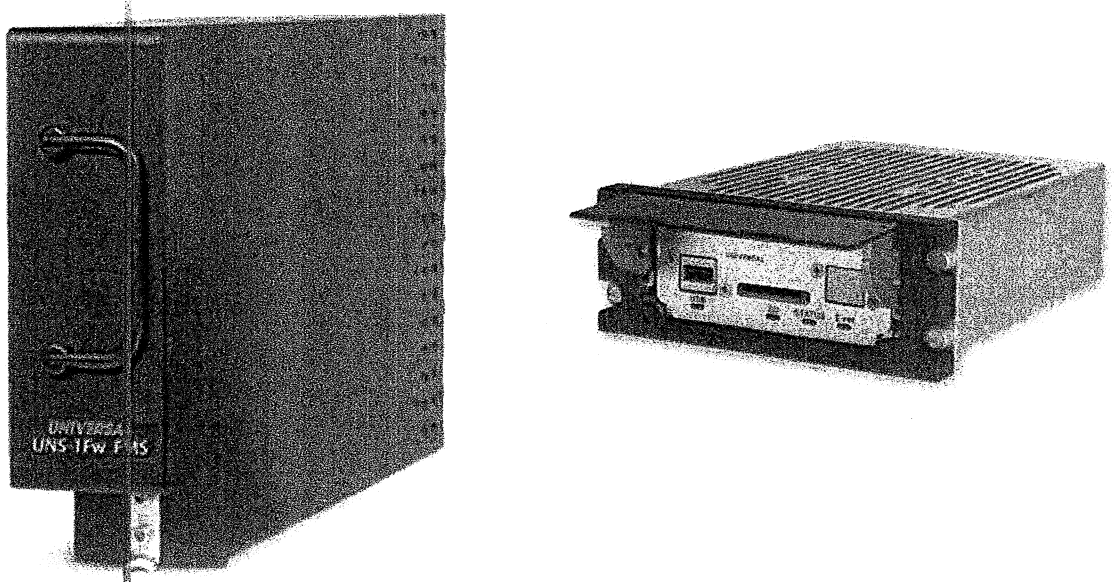


Figure 14: UNS-1Fw FMS and SSDTU

5.5 SOLID STATE DATA TRANSFER UNIT

Supporting Universal Serial Bus (USB) and Secure Digital (SD) media, the Solid-State Data Transfer Unit (SSDTU) can represent the next generation of data upload and download equipment. Easily accessible, high-speed media ports are conveniently located in the faceplate allowing for quick data file transfers between a USB drive or SD card and the aircraft's avionics systems. The SSDTU interfaces with up to eight Line Replaceable Units (LRU). The SSDTU uploads the navigation databases and downloads internal memory IFDR files for post flight debriefing and analysis using Universal Avionics' Flight Review utility.

5.6 V/UHF UNIT

The Rockwell Collins ARC-210 Gen5, is the most advanced Receiver-Transmitter (RT) in the proven ARC-210 communication system family. Rockwell Collins has supplied more than 38,000 AN/ARC-210 radios worldwide on over 180 platforms, making them the accepted choice for multiband, multimode communications.

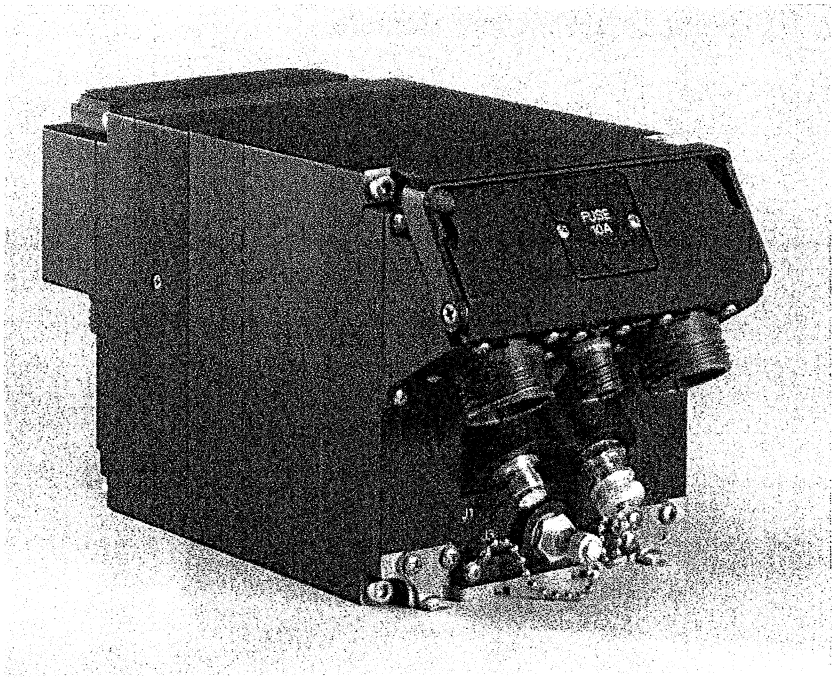


Figure 15: ARC-210 U/VHF

5.6.1 MAIN FEATURES

- Control via 1553 or RS-422/RS-485
- Embedded software programmable cryptography
- Multiwaveform software architecture
- Extensible module interconnect for future scalability and growth
- Interoperable with a variety of high power amplifiers, low noise amplifiers, tunable filters and interference cancellation systems
- Compatible with ICAO Annex 10 and ED-23B, including FM immunity
  - 8.33 kHz operation

5.7 IFF UNIT

The APX-119, a combined Mk XIIA / Mode S / Mode 5 /ADS-B capable / AIMS certified transponder, enables aircraft to operate seamlessly throughout international, civil, and military airspace, while meeting all IFF and ATC requirements. Utilizing the latest digital processing technologies, the APX-119 provides positive identification and increased safety, while incorporating full Mk XIIA, Mode S, Mode 5 and ADS-B capabilities into flexible open system architecture.

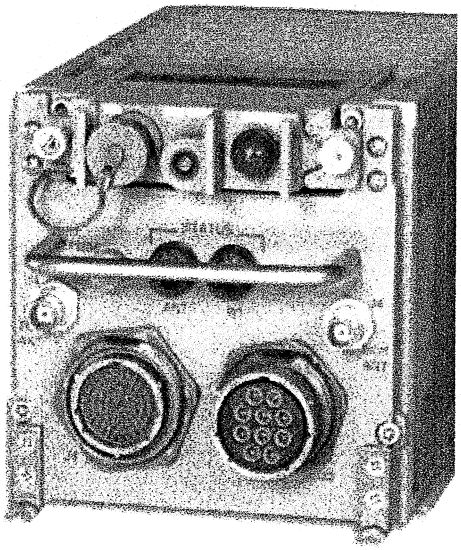


Figure 16: APX-119 IFF

5.8 ADF UNIT

The Rockwell Collins AN/ARN-149(V) is the first low-frequency automatic direction finder to provide an internal, field-upgradable MIL-STD-1553B digital multiplex bus capability. This system, consisting of a receiver, antenna and mount, provides a low-frequency automatic direction finding function in a lightweight, easily installed set. The all solid-state receiver eliminates all moving parts such as goniometers, synchros and mechanical tuners. Quadrantal Error Correction (QEC) is set by aircraft connector strapping, eliminating corrector modules and airframe-specific internal adjustments. The antenna combines the loop and sense antennas and preamplifiers in one compact housing, thereby eliminating expensive sense panels, couplers and special prefabricated.

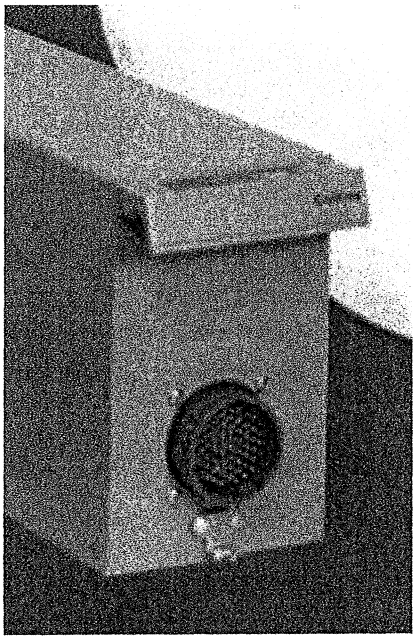


Figure 17: AN/ARN-149(V) ADF

5.9 VOR/ILS UNIT

The ARN-147 is recognized worldwide as a value added solution on multiple military platforms. Originally designated as the standard VOR/ILS receiver for the United States Air Force, the ARN-147 quickly gained acceptance by many military users around the world and is installed on a multitude of platforms including C-130, C-141, C-5, UH-1N, CH-47, UH-60, T-50 and JAS 39 Gripen. The ARN-147 is a proven design derived from extensive experience in navigation and precision approach and landing systems. As a leading supplier of these systems, Rockwell Collins has designed and manufactured more than 100,000 VHF navigation and landing systems

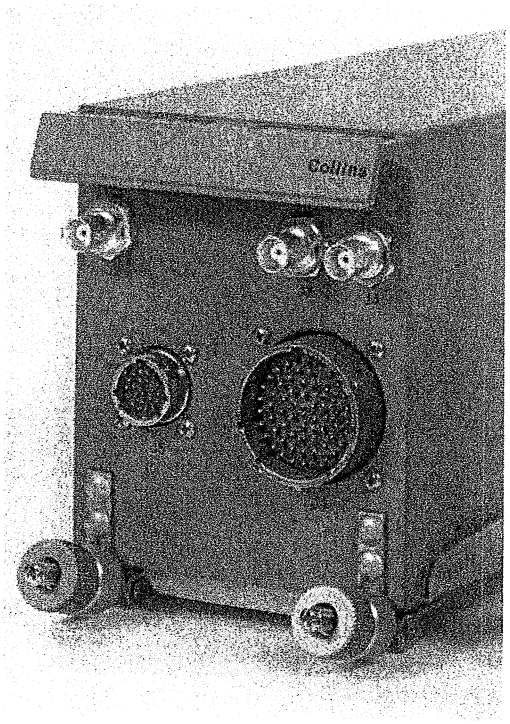


Figure 18: AN/ARN-147 VOR/ILS

5.10 DME UNIT

DME-4000 Distance Measuring Equipment is a member of the Collins Pro Line 21 CNS family of products that feature state-of-the-art digital signal processing technology, digital audio, a consolidated tuning/data/audio bus, comprehensive maintenance software and software data loading. Remote-mounted, multichannel DME which operates on 252 channels from 960 to 1215 MHz with both X and Y pulse-pair spacings with a transmitter output power of 300 watts minimum and a minimum receiver sensitivity of -85 dBm.

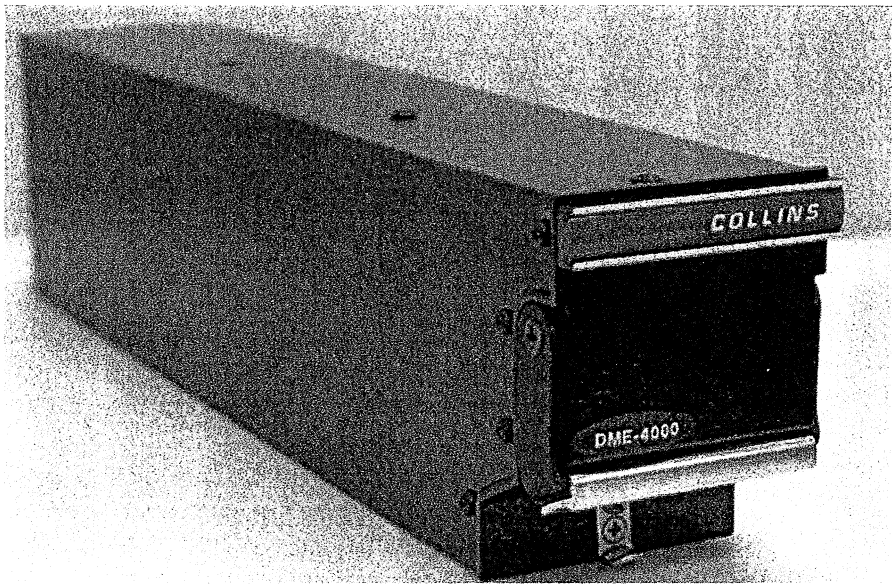


Figure 19: DME-4000

5.11 AHRS UNIT

The Northrop Grumman LISA-200 AHRS, is a lightweight Fiber Optic Gyroscope (FOG) Attitude Heading Reference System (AHRS) based on the state-of-art Northrop Grumman LN-200 Inertial Measurement Unit and Northrop Grumman 20 years of experience in the design, development, and manufacturing of inertial navigation systems. Qualified to DO 160/MIL-STD-810 requirements and certified according to DO 178B, the LISA-200 AHRS is in full production and is in service worldwide on several military rotary and fixed wing aircraft.
LISA-200 AHRS was already integrated with the UH-60 AFCS.

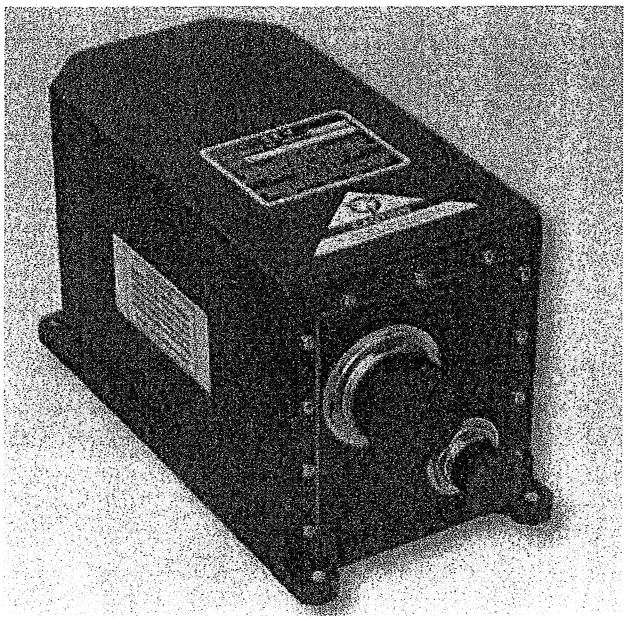


Figure 20: LISA-200 AHRS

5.10 DME UNIT

DME-4000 Distance Measuring Equipment is a member of the Collins Pro Line 21 CNS family of products that feature state-of-the-art digital signal processing technology, digital audio, a consolidated tuning/data/audio bus, comprehensive maintenance software and software data loading. Remote-mounted, multichannel DME which operates on 252 channels from 960 to 1215 MHz with both X and Y pulse-pair spacings with a transmitter output power of 300 watts minimum and a minimum receiver sensitivity of -85 dBm.

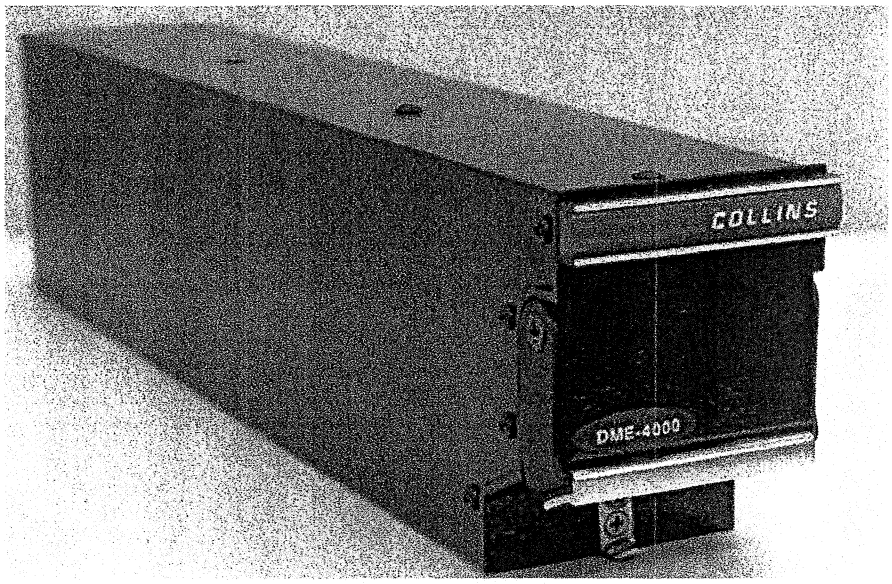


Figure 19: DME-4000

5.12 MISSION PREPARATION STATION (MPS)

5.12.1 GROUND STATION GENERAL DESCRIPTION

- The System is provided with a dedicated ground station for pre-flight preparation. The ground station is used for loading data such as map tactical data base and terrain data.
- The following is loaded and prepared on the ground station:
- Map & Terrain database

The ground station is based on Commercial-Off-The-Shelf (COTS) PC packed in a ruggedized box.

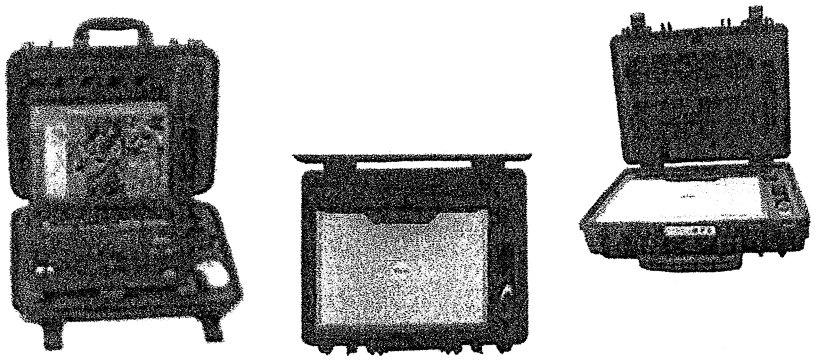


Figure 21: Mission Planning Ground Station

5.12.2 GROUND STATION TECHNICAL DESCRIPTION

- Mobile workstation.
- Wireless mouse.
- Ethernet Cable.

5.12.3 GROUND STATION FUNCTIONAL DESCRIPTION

Pre-flight Mission Planning:

- Data bank preparation for recurring mission usage
- Data Base load to the MFDs.

APPENDIX A – List of Abbreviations

A/C	Aircraft
ADN	Advanced Day & Night
AMLCD	Active Matrix LCD
ASDC	Advanced Sight and Display Computer
AHHS	Altitude Hold & Hover Stabilization
AHRS	Attitude Heading Reference Systems
BFE	Buyer Furnished Equipment
BIT	Built In Test
BRT	Bright
CADRG	Compressed Arc Digitised Raster Graphics
CBIT	Continuous Built-In Test
CCA	Circuit Card Assembly
CCD	Charge-Coupled Device
CDU	Cockpit Display Unit
CG	Centre-of-Gravity
COR	Center of Rotation
DIU	Display Interface Unit
DM	Display Module
DMAP	Digital Map
DTED	Digital Terrain Elevation Data
ECL	Electronic Check List
EOP	Electro-Optical Payload
FOV	Field Of View
FMS	Flight Management System
H/C	Helicopter
GUI	Graphical User Interface
HAT	Height Above Threshold
HMD	Helmet Mounted Display
HMI	Human-Machine Interface
HMS	Helmet Mounted System
HOCAS	Hands on Collective & Stick
HUD	Head-Up Display
HVI	Human-Vehicle Interface

H/W, HW	Hardware
IR	Infrared
LCD	Light Crystal Display
LED	Light Emitting Diode
LRU	Line replaceable unit
LZ	Landing Zone
MAWS	Missile Approach Warning System
MCCU	Mini Converter Control Unit
MFD	Multi-Function Display
MFTD	Multi-Function Touch Display
MFL	Maintenance Failure List
MMS	Mass Memory Storage
MMR	Multi-Mode Radar
MPS	Mission Preparation Station
MSG	Message
NVG	Night Vision Goggles
NVIS	Night Vision Imaging System
OLED	Organic LED
OU	Optical Unit
PCB	Printed Circuit Board
P&O	Position and Orientation
PVI	Pilot-Vehicle Interface
SAS	Sun Angle Shading
SRU	Shop Replaceable Unit
STBY	Standby
S/W	SW Software
VMAP	Vector Map
VIP	Video and Interface Processor
WOS	Weight On Skids
XGA	Extended Graphics Array (1024x768 resolution)